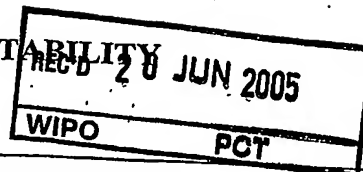


**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY**  
(Chapter II of the Patent Cooperation Treaty)  
(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 501757 EMN/mjw		<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. <b>PCT/NZ2004/000134</b>		International filing date (day/month/year) 25 June 2004	Priority date (day/month/year) 25 June 2003	
International Patent Classification (IPC) or national classification and IPC Int. Cl. <sup>7</sup> H04L 27/26, H04L 1/00				
Applicant <b>INDUSTRIAL RESEARCH LIMITED et al</b>				

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
  - a. ☒ (sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:
    - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
    - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
  - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

- |   |   |
|---|---|
| <input checked="" type="checkbox"/> Box No. I | Basis of the report   |
| <input type="checkbox"/> Box No. II           | Priority  |
| <input type="checkbox"/> Box No. III          | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability  |
| <input type="checkbox"/> Box No. IV           | Lack of unity of invention  |
| <input checked="" type="checkbox"/> Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> Box No. VI           | Certain documents cited   |
| <input type="checkbox"/> Box No. VII          | Certain defects in the international application  |
| <input type="checkbox"/> Box No. VIII         | Certain observations on the international application   |

Date of submission of the demand  
26 April 2005

Date of completion of the report  
14 June 2005

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# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/NZ2004/000134

## Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
  - ☐ This report is based on translations from the original language into the following language which is the language of a translation furnished for the purposes of:
    - ☐ international search (under Rules 12.3 and 23.1 (b))
    - ☐ publication of the international application (under Rule 12.4)
    - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:
  - ☐ the international application as originally filed/furnished
  - ☒ the description:
    - pages 1-25 as originally filed/furnished
    - pages\* received by this Authority on with the letter of
    - pages\* received by this Authority on with the letter of
  - ☒ the claims:
    - pages as originally filed/furnished
    - pages\* as amended (together with any statement) under Article 19
    - pages\* 26-29 received by this Authority on 26 April 2005 with the letter of the same.
    - pages\* received by this Authority on with the letter of
  - ☒ the drawings:
    - pages 1-11 as originally filed/furnished
    - pages\* received by this Authority on with the letter of
    - pages\* received by this Authority on with the letter of
  - ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
  - ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
  - ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to the sequence listing (*specify*):

\* If item 4 applies, some or all of those sheets may be marked "superseded."

# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/NZ2004/000134

**Box No. V** Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims 1-20	YES
	Claims	NO
Inventive step (IS)	Claims 1-20	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-20	YES
	Claims	NO

## 2. Citations and explanations (Rule 70.7)

### Novelty and Inventive Step

None of the citations in the International Search Report, individually or in combination, discloses all of the features of the claimed invention. In particular they do not disclose the placement of the excision filter before the FFT is an OFDM receiver or the use of the phase or magnitude of the interfering signal.

## CLAIMS

1. A method of suppressing narrowband interference in OFDM receivers including the steps of;

- 5 acquiring a sample of received data,  
estimating parameters of each of a number of narrowband interferers from the acquired sample of data,  
forming an excision filter using the estimated parameters, and  
inserting the excision filter into an OFDM receiver prior to a discrete Fourier  
10 transform.

2. A method of suppressing narrowband interference in OFDM receivers as claimed in claim 1 wherein the estimated parameters of the narrowband interferers include demodulated carrier frequency, magnitude and phase.

3. A method of suppressing narrowband interference in OFDM receivers as claimed in claim 1 or claim 2 wherein the step of estimating the number of narrowband interferers includes the steps of;

- 15 performing a forward DFT on the samples, and  
20 performing a periodogram search on the output of the DFT to identify peaks in the periodogram where the number of peaks in the periodogram corresponds to the number of interferers.

4. A method of suppressing narrowband interference in OFDM receivers as claimed in any one of claims 1 to 3 wherein the step of estimating parameters of the narrowband interferers includes the steps of;

25 estimating the frequency of an interferer as the frequency of a peak on the corresponding periodogram,

30 estimating the magnitude of the interferer as the amplitude of the corresponding periodogram peak, and

estimating the phase of the interferer as the phase of the corresponding periodogram peak.

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5. A method of suppressing narrowband interference in OFDM receivers as claimed in any one of claims 1 to 4 including the step of initialising one digital phase lock loop for each estimated narrowband interferer using the narrowband interferer parameter estimates.
6. A method of suppressing narrowband interference in OFDM receivers as claimed in any one of claims 1 to 5 further including the step of receiving an indication of a start of packet when a data packet is received by the OFDM receiver.
7. A method of suppressing narrowband interference in OFDM receivers as claimed in claim 5 including the step of updating each phase lock loop each incoming sample until either a counter expires or an OFDM packet is detected.
8. A method of suppressing narrowband interference in OFDM receivers as claimed in claim 7 wherein the phase locked loops are digital phase locked loops.
9. A method of suppressing narrowband interference in OFDM receivers as claimed in any one of claims 5, 7 and 8 including the step of initialising the excision filter with the current narrowband interferer carrier frequency estimates from the phase locked loops that have achieved "lock" when an OFDM packet is detected.
10. An OFDM receiver including;  
a front end arranged to receive data,  
a data sampler arranged to provide samples of received data,  
a narrowband interference detector that detects narrowband interferers in the sample of received data and estimates parameters of each narrowband interferer, and  
an excision filter that uses the estimated parameters of each narrowband interferer to reduce noise from the narrowband interferers wherein the excision filter is inserted in the OFDM receiver prior to a Fourier transform.

11. An OFDM receiver as claimed in claim 10 wherein the narrowband interference detector estimates the demodulated carrier frequency, magnitude and phase of the narrowband interferers.

5 12. An OFDM receiver as claimed in claim 10 or claim 11 wherein the narrowband interference detector includes a Fourier transform operator arranged to perform a Fourier transform on the samples and perform a periodogram search on the output of the Fourier transform operator to identify peaks in the periodogram and at least one phase lock loop arranged to lock onto a peak identified by the periodogram search.

10 13. An OFDM receiver as claimed in claim 12 wherein the narrowband interference detector is further arranged to estimate the frequency of an interferer as the frequency of a peak on the corresponding periodogram, estimate the magnitude of the interferer as the amplitude of the corresponding periodogram peak, and estimate the phase of the  
15 interferer as the phase of the corresponding periodogram peak.

14. An OFDM receiver as claimed in any one of claims 10 to 13 wherein the narrowband interference detector includes a timer and a filter design module.

20 15. An OFDM receiver as claimed in any one of claims 10 to 14 wherein the OFDM receiver is further arranged to provide an estimate of the start of an OFDM data packet to the narrowband interference detector.

25 16. An OFDM receiver as claimed in claim 15 wherein the narrowband interference detector is arranged to innovate the phase lock loop(s) until either the timer times out or an OFDM packet is received.

30 17. An OFDM receiver as claimed in claim 16 wherein the phase locked loops are arranged to estimate the carrier frequency of the narrowband interferers.

18. An OFDM receiver as claimed in claim 17 wherein one phase locked loop is used for each interferer.

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19. An OFDM receiver as claimed in any one of claims 16 to 18 wherein the current narrowband interferer carrier frequency estimates from the phase locked loops that have achieved "lock" are used by the filter estimator to initialise an excision filter when an  
5 OFDM packet is detected.
20. An OFDM receiver as claimed in any one of claims 10 to 19 wherein the excision filter has impulse response duration less than the OFDM guard interval.